Claims

[c1] What is claimed is:

1.A method of identifying load and motor fault information in a condition monitoring system comprising the steps of:

simultaneously sampling voltage and current data of an induction machine in operation;

determining an indicator of reactive power from a portion of the sampled voltage and current data; and

determining an internal motor fault using the indicator of reactive power.

[c2] 2.The method of claim 1 further comprising the steps of determining an indicator of real power from another portion of the sampled voltage and current data and determining a load fault from the indicator of real power.

[c3] 3.The method of claim 2 further comprising the step of determining a frequency spectrum of real power and a frequency spectrum of reactive power.

[c4] 4.The method of claim 3 further comprising the steps of analyzing the frequency spectrum of reactive power to determine a motor fault and analyzing the frequency spectrum of the indicator of real power to determine a load fault.

[c5] 5.The method of claim 4 wherein the load fault includes a motor driven fault.

[c6] 6.The method of claim 1 further comprising the steps of:

determining two-phase voltages and two-phase current values from the sampled voltage and current data;

determining a reference frame transformation angle from the two-phase voltage values; and

transforming the two-phase current values and the two-phase voltage values to a rotating reference.

[c7] 7.The method of claim 1 wherein the reactive power is an instantaneous reactive power.

[c8] 8.An induction motor monitoring system comprising:

at least one voltage sensor and at lease one current sensor; and

a controller connected to the at least one voltage and the at least one current sensors and configured to:
receive voltage and current data from the at least one voltage and the at least one current sensor;
determine instantaneous reactive power from the voltage and current data;
generate a frequency spectrum of the instantaneous reactive power; and
determine a motor fault from at least the frequency spectrum.

[c9] 9.The system of claim 8 wherein the at least one voltage sensor includes a pair of voltage sensors configured to acquire line-line voltages of two phases of an induction motor and wherein the at least one current sensor includes a pair of current sensors configured to acquire line-line currents of the two phases of the induction motor and wherein the controller is further configured to determine two-phase voltage and two-phase current values from the voltage and current data.

[c10] 10.The system of claim 9 wherein the controller is further configured to determine a reference frame transformation angle and apply a reference frame transform to transform the two-phase voltage and the two-phase current values to a rotating reference using the reference frame transformation angle.

[c11] 11.The system of claim 10 wherein the controller is further configured to determine the instantaneous reactive power from the transformed two-phase voltage and the transformed two-phase current values.

[c12] 12.The system of claim 11 wherein the controller is further configured to determine an instantaneous real power value from the transformed two-phase voltage and the transformed two-phase current values.

[c13] 13.An apparatus to distinguish between a motor fault and a load fault in an AC induction motor, the apparatus comprising:
at least two current sensors for obtaining at least two AC motor current signals;
at least two voltage sensors for obtaining at least two AC motor voltage signals;
an analog-to-digital converter for converting the at least two AC motor current signals to digitized current signals and the at least two AC motor voltage

signals to digitized voltage signals; and

a microprocessor to receive the digitized signals and compare instantaneous reactive power values to a set of baseline reactive power values to determine a motor fault in the motor.

[c14] 14.The apparatus of claim 13 wherein the microprocessor computes a frequency spectrum of the instantaneous reactive power values and compares the frequency spectrum to a baseline reactive power frequency spectrum to determine the motor fault.

[c15] 15.The apparatus of claim 13 wherein the microprocessor applies a reference frame transformation to the digitized signals prior to calculating the instantaneous reactive power values.

[c16] 16.The apparatus of claim 13 wherein the processor calculates instantaneous real power values from the digitized signals and compares the instantaneous real power values to a set of baseline real power values to determine a motor-driven fault in the AC motor.

[c17] 17.The apparatus of claim 16 wherein the processor computes a frequency spectrum of the instantaneous real power values and compares the frequency spectrum to a baseline real power frequency spectrum to determine the motor driven fault.

[c18] 18.A computer readable storage medium having a computer program stored thereon to determine faults in an AC induction motor and representing a set of instructions that when executed by a computer causes the computer to:

model operation of an AC motor having a load thereon and known to be operating normally and determine baseline operation therefrom;

acquire real-time voltage and real-time current data of the AC motor in operation;

determine reactive power of the AC motor from the real time voltage and real-time current data;

compare the reactive power to the baseline operation; and

determine presence of fault conditions in the AC motor from at least the

comparison.

[c19] 19.The computer readable storage medium of claim 18 wherein the set of instructions further causes the computer to issue a warning if a fault condition is found to be present in the AC motor.

[c20] 20.The computer readable storage medium of claim 18 wherein the set of instructions further causes the computer to apply a reference frame transform to the real-time voltage and real-time current data.

[c21] 21.The computer readable storage medium of claim 18 wherein the set of instructions further causes the computer to generate a frequency spectrum of the reactive power and display the frequency spectrum on a console for visual analysis by a user.

[c22] 22.The computer readable storage medium of claim 21 wherein the set of instructions further causes the computer to display the frequency spectrum of the reactive power relative to a frequency spectrum of the baseline operation to visually indicate a fault condition in the AC motor.

[c23] 23.A motor fault detector for an AC induction motor, the detector comprising:
means for acquiring voltage and current data of an AC motor in operation;
means for determining instantaneous reactive power in the AC motor from the voltage and current data; and
means for determining an internal fault in the AC motor from the instantaneous reactive power.